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ABSTRACT

These proceedings address five themes that emerged from discussions among 28 of the nation's most experienced leaders in the uses of technology in higher education: (1) access and equity; (2) quality teaching and learning environments; (3) training and support systems; (4) collaboration and cooperation; and (5) finance. Technical, attitudinal, and structural obstacles pervading each of these themes are discussed in the four major parts of the report. Part I summarizes key points from the round table discussions, highlighting the urgent need for cooperation between institutions of higher education and between telecommunications consortia to avert obstacles to the intelligent use of technology. Part II contains a discussion paper commissioned by the Academy for Educational Development, "Exploring Obstacles to Uses of Technology in Higher Education" (Raymond Lewis and Milan Wall), which explores the five themes and the obstacles to technology adoption in both distance education and on-campus learning environments. Case studies illustrating successful technology applications in the Maricopa County Community College District in Arizona and at Rochester Institute of Technology in New York are included in Parts III and IV. A list of conference participants is provided. (GL)

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WIRING THE IVORY TOWER:
A Round Table on Technology in Higher Education

Donald R. McNeil

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Introduction

"Technology in Higher Education," a two-day conference sponsored by the Academy for Educational Development in Washington, D.C., in December 1988, brought together 28 of the nation's most experienced leaders in the uses of technology in higher education. The purpose of the conference, called the Technology Round Table, was to foster discussion among the participants on the uses of information technologies in teaching and learning. The conference grew out of the Academy's long commitment to sponsoring appropriate applications of technology to meet educational goals. The summary of the round table discussions appears in Part I of this report.

Prior to the round table, the participants – representing industry, labor, foundations, government, and higher education – received a paper the Academy had commissioned. The paper, "Exploring Obstacles to Uses of Technology in Higher Education" by Raymond Lewis and Milan Wall, outlines the various obstacles confronting colleges and universities as technology becomes an increasingly vital part of their instructional, counseling, and administrative programs. The paper, which emphasizes instructional uses, constitutes Part II of this report.

The conferees met both in general session and in small discussion groups. During the discussions, it became clear that boundaries could not be drawn around any of the three categories of obstacles; that attitudinal, technical, and structural problems overlap and intrude upon each other in ways that defy easy categorization.

Instead, five themes emerged from the discussions:

- Access and equity
- Quality teaching and learning environments
- Training and support systems
- Collaboration and cooperation
- Finance

The technical, structural, and attitudinal obstacles pervaded all five of these major themes. Almost every one of the obstacles mentioned in the Lewis-Wall paper was addressed but usually in terms of these five themes. Many of the questions raised during the round table merely hint at some of the more complex issues and strategies needed to overcome the numerous obstacles. We hope this summary of the conference will stimulate discussion and action in other institutions of higher education regarding the measures and strategies suggested by this group.

The two case studies in Parts III and IV may be of further help to those institutions desiring to apply technology intelligently. Two of the institutions represented at the conference – the Maricopa Community College District and the Rochester Institute of Technology – incorporated in their activities many of the themes that emerged from the conference, and their experiences provide models for other institutions.

I offer my sincere thanks to Jan Baltzer of the Maricopa County Community College District and Sue Rogers of the Rochester Institute of Technology, who spent a great deal of time and energy in providing the basic documentation for the two case studies.

Without the paper by Raymond Lewis and Milan Wall, the Technology Round Table would not have been the same. The paper provided a focus for the discussions and sparked many lively conversations during the two days. A special word of thanks is due to Melissa Kirchner, who was associated with every part of the round table – the invitations, the logistics of the meetings, and the preparation of this publication. I am grateful to Frances Hays for her superb editing of the entire manuscript.

The conference reenforced my belief that training is of the highest priority and that attitudinal problems constitute the single greatest obstacle to using technology. While cost savings may be made here and there, technology will not "save" huge amounts of money. Technology will be effective and accepted only when our educators realize that applied appropriately, it can improve quality, productivity, and access.

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PART I

Summary Report:
ROUND TABLE ON TECHNOLOGY IN HIGHER EDUCATION

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"Current communications technology has become part of the social fabric of our institutions," noted one of the university participants. This statement followed several general propositions agreed to by members of the conference:

- The globalization of information is increasing at a fast pace as technology continues to diminish constraints of time and distance.
- The need for a skilled work force is escalating rapidly as technology transforms the functions of the individual worker and as competition with other nations grows.
- Improving productivity holds the key to the future economic success of the United States.
- Economic development is becoming increasingly dependent upon the educational system, forcing institutions, states, and nations to look at the "economics of knowledge."
- The infrastructure of the "information society" should be our educational system.
- The educational system is undergoing technological changes that challenge current assumptions about how people are taught, when they are taught, where they are taught, and the length of time they need to master particular subject matter.

Several overall conclusions about the use of technology in higher education gave hope to many of the participants. First, although numerous limitations and obstacles to the use of technology exist, they can be overcome and, in fact, are probably not as great as once thought. Second, a sizable number of institutions have accepted technology as an essential feature of their future existence, including institutions both small and large, wealthy and poor, and public and private. "Technology initiatives," said one participant, "are more widespread than is commonly perceived."

Despite this acceptance, the number of institutions and faculty members involved in significant technology-based programs remains relatively small. And, finally, attitudinal issues – how people perceive and react to these technologies – are far more important now than structural and technical obstacles in influencing the use of technology in higher education.

Conference participants concentrated their discussions on five major themes that embraced both these general conclusions and the obstacles delineated in the Lewis-Wall paper:

- Access and equity
- Quality teaching and learning environments
- Training and support systems
- Collaboration and cooperation
- Finance

Key points from the round table discussions are presented in the following sections.

Access and Equity

Almost all the conferees placed the need to increase access and equity high on the list of important questions. Distance education figured prominently as a means of achieving these goals. With technology, institutions are able to reach new audiences in different places at different times – often at the convenience of both the learner and the teacher.

These developments will encourage institutions to re-examine their assumptions about where and how people learn. For too long, institutions have focused on the *input* to the educational process, a concern which favors institutional and teacher needs; colleges and universities should be more *outcome* oriented with concentration on learning and the needs of the learner. Such an emphasis would lead institutions to examine the possibilities of alternative instructional delivery systems using a variety of technologies. Moreover, this trend would ultimately lead to a system that values performance rather than attendance.

With technology, institutions can provide adults a second chance at a college education, can reach those handicapped by time or distance or by physical disability, and can update the knowledge base of workers at their places of employment. The need to train for new types of jobs and upgrade current jobs was frequently noted as an impetus for developing technology-based education programs. Technology also can be a valuable tool for delivering remedial services to both on-campus and off-campus students. Of special interest is the possibility of using technologies to provide learning opportunities to rural areas. Those who are not served at all, as well as the underserved, deserve attention; "at risk" students, also, can be helped through technology. "Look to new boundaries," said one of the members. "Technology will change the present ones, and it offers opportunities that were not there before."

One of the business representatives urged colleges and universities to take risks as they attempt to reach new audiences through technology. "Distance learning is the wave of the future," one of the discussion groups concluded. More than ten million people in the world now learn through distance education programs, a college president noted, but Americans are not a significant portion of that number. Several participants pointed out how hostile many faculty members are toward distance learning, regarding it as an inferior and second-rate mode of education. Thus, advocates of distance learning face many challenges in overcoming the hostility engendered by technology itself as well as the prejudice against distance learning.

Much job training and retraining will occur in the workplace, the group predicted, and colleges and universities should be getting ready for those changes by becoming involved with technologies now. In many instances, business and industry already have established their own compensatory and remedial programs to make up for the lack of preparation of their employees.

Another critical element facing institutions that utilize technology in their distance learning programs is the attitude of state coordinating agencies and accrediting bodies. Here, too, deep feelings that range from misunderstanding to suspicion and antagonism prevail. Such animosities and misconceptions are aggravated when programs cross state or jurisdictional lines. Under these circumstances, innovative programs that use technology to reach distance learners become difficult to initiate.

Several members of the conference mentioned another form of inequity. They worried about the ability of smaller and poorer institutions to take advantage of communication and information technologies. Schools with large enrollments often have great audio, video, and computer capacities, while smaller ones do not. This disparity between richer and poorer institutions should be eliminated through better funding by both state and federal agencies and through collaboration of institutions in consortia.

Quality Teaching and Learning Environments

There was general agreement that technology, if used properly and appropriately, could enhance the quality of instruction either on campus or off campus. Participants stressed that technology should not be a solution going in search of a problem, but that identification of the problem should come first with identification of appropriate technologies to use to solve the problem coming next.

For example, an institution designing a program to serve an isolated rural area should not start with a video-based or computer-based program without knowing the extent to which the prospective learners have access to VCRs or computers. Audio programs supplemented by periodic visits by professors might provide a more practical solution. First comes the problem, then the choice as to which technology, if any, is most suitable.

Proper costing out of the various technologies becomes most important. Too many institutions concentrate on the hardware and software and do not plan for the expense of maintenance and of training for staff, faculty, and students. Great emphasis was placed on the need to make both faculty and students comfortable with the technology they will be using.

Round table participants also felt that the use of new technologies could result in improved student-teacher interaction. Despite its reputation for dehumanizing the learning process, technology can be humanizing by relieving tedium, offering more options to learners, and bringing teachers and students closer together through interactive programs that stress rapid responses.

The group also felt that significant progress is being made toward product compatibility. Although product standardization is not likely, product compatibility offers the user the same advantages as if hardware and software were standardized. Market demands have had a powerful impact on enhancing compatibility. Recent developments such as computer networks that can handle multiple models, interchangeable hardware and software, and the joining of voice, data, and video in one machine are examples of the progress now being made toward compatibility.

Many administrators, faculty members, and students are still wary of technology and do not want to be involved in its use. Luring members of the academic community into the world of technology is not an easy task. Changing attitudes toward the use of technology for instruction becomes a psychological challenge.

The process of introducing and converting higher education institutions to the use of technology must be aimed at all levels, especially at the top administrative level, the group concluded. Administrators need to be convinced that technology can help in the management of programs as well as the support of instruction. The commitment of the top administration is crucial to the successful use of technology applications. Such commitment sets the tone for acceptance at all levels of the institution and provides the necessary backing for staff and faculty.

For their part, faculty need released time, adequate hardware and software, and support from technical experts. A change in the reward system for faculty is critical. Most faculty now take on using technology as an extra task. Even if technology applications are part of an institution's program, most promotion and tenure systems make no provision for rewarding a professor who experiments with or uses technology to reach

students either on or off campus. Faculty members need performance-based merit increases and promotions that include recognition of activities in using technology as well as in publishing. Ultimately, faculty should be able to regard the use of technology as a means of moving up the career ladder as well as of gaining personal and professional renewal.

Faculty also should have greater involvement in decision making about technology because they are the ones who will be using it for instructional purposes. Technical coordination and support should be provided for this process. And while faculty should be aware of administrators' needs for technology, faculty should be in a position to present their needs on a competitive basis. Until these alternate methods of delivering instruction are accepted as integral parts of the academic process and faculty are rewarded accordingly, little expansion in the use of technology on campuses will occur.

The search for resources to create friendly teaching-learning environments through technology is a critical factor in the success of technology applications. Too often administrators think only in terms of up-front expenditures for hardware and software. Other resource considerations are critical. Maintenance of equipment, technical support for the users, money for "incubator" projects to foster innovation, built-in allowances for amortization were all mentioned as important aspects of the support system needed to insure that technology is widely utilized.

Modifying the infrastructure of the institution becomes an important factor, too. The accessibility of large data bases through the library; the creation of networks among faculty, administrators, and students; and software applications for counseling, registration, and records all call for some degree of change in attitude as well as in function.

The lack of first-rate software and the need to adapt software to the faculty's existing teaching requirements have proven to be formidable problems in many institutions. Each faculty member is responsible for teaching particular classes and will have different ideas as to how and to what extent technology should be used. The use of technology changes the pedagogy. Teaching at a distance or using videotapes or interactive computers to supplement lectures calls for different methods than those used in standard lecture courses. Increased student involvement, more discussion of a seminar type, and greater reliance on critical comments and questions characterize technology-based courses.

Research is another area in which technology can help faculty members adjust to the new order. Through the computer, faculty can communicate with scholarly colleagues quickly and at great distances. With the advent of electronic mail and computer conferencing, cooperative research projects have increased tenfold.

Training and Support Systems

Establishing a friendly teaching-learning environment through provision of adequate resources, good incentives, and opportunities to experiment is closely associated with one of the greatest needs of all – training programs and the support systems to back them up.

Over and over the need for adequate training was stressed. Administrators and faculty members need to be trained in the uses of the hardware and software. For faculty

who want to adapt software to their courses or create software themselves, training in programming and curriculum development is also necessary.

In a related discussion, several members felt that software design needed to be raised to the level of a discipline. With technology as a tool, professors will no longer be able to work entirely alone. They will have to adopt a team approach, with appropriate technical experts and curriculum designers working together as an instructional design team. Professors will require training to move from their once isolated position of designing entire courses by themselves to using the team approach.

Most participants agreed that the need for training will remain constant. New products on the market require new training for students, faculty, and administrators. Combining technologies in new delivery systems intensifies the need for further training. And new students and new faculty members create demands for ongoing training programs.

Facilities, too, will have to be modified. Most classrooms are ill-suited for video-, audio-, or computer-aided instruction and will require significant alteration to accommodate the technologies in order to maintain the rhythm, style, pacing, and substance of instruction.

But it was not just training in the use of hardware and software that concerned the participants. Training in *how* to teach with technology is just as important. Teaching learners at a distance calls for different techniques and methods than meeting with learners at a specific location at a specified time. Using computers for purposes of interacting with students demands methods and techniques – usually with heavy student involvement in back-and-forth discussions – different than the traditional lecture methods used by most faculty.

Collaboration and Cooperation

One of the points most frequently expressed in the conference was the need for cooperation and collaboration. That sense of cooperation should begin within the institution, several participants stressed. Technology is too expensive to let individual units create their own empires. Cooperation between departments, between individual faculty members and the computer center, between faculty members and students, and between administrators and faculty is necessary to take full advantage of technology in the academic setting.

Networking will enhance a sense of collaboration. Equitable allocation of funds for hardware and software will bring diverse groups together. If the total institution is committed to technology and a comfortable teaching-learning environment is established, interdisciplinary collaboration will result.

The participants called for other kinds of collaboration, too. The trend toward business-higher education partnerships can be accelerated through the use of technology. Industry's experience in using technology should be tapped. Labor unions should be contacted to see how the educational institution, by using technology, might create a better delivery system for union members. Larger, more affluent colleges and universities should create linkages with smaller institutions. Rural areas, especially, will need technical help to make decisions about the use of technology and are good markets for distance education programs using appropriate technologies. Institutions of all sizes should begin collaborating not only to

unify as bases of knowledge but also to share the high costs of some applied technologies.

While the development of personal computers has resulted in great numbers of networks with less reliance on mainframe computers, many of the technologies are very expensive and require more centralization. States are beginning to look at their total telecommunications needs; some are buying dedicated transponders, while others are installing fiber optic lines to connect campuses with other state institutions. With educational institutions delivering distance education programs via technology, states are having to become increasingly involved. Coordinating boards and higher education commissions with the responsibility of monitoring all programs are reviewing those programs in light of individual state laws that govern new programs and the involvement of out-of-state institutions.

One of the major strategy recommendations to come out of the conference was the call for the establishment of one or more research and development technology centers. These centers would encourage compatibility of software, give focus to a national software development initiative, and stimulate research. In addition to designing training programs, the centers could provide the actual training programs for those who would be training others in the uses of technology. They could act as clearinghouses of information on the uses of technology anywhere in the world and manage collaborative efforts that were too large for any one institution to handle. In short, the technology centers would, with full cooperation of the constituencies, provide leadership for expanding the uses of technologies in colleges and universities.

As one participant stated, "We need institution-building of a kind that will give both prominence and permanence to the development and extension of technology throughout higher education." Or as another member suggested, "The focus of the centers would be to examine the use of technologies to resolve learning problems in very specific areas."

Finance

While most participants agreed that more funds were going to be needed to make the use of technology effective and widespread, there were sharp differences as to how technology should be paid for. Several members advocated increased federal funding, especially for hardware and software. Others felt that partnerships among educational institutions, industry, and federal and state agencies provided a more realistic approach to financing the adaptation of technology to the institutions.

As disciplines in the social sciences and the humanities begin to use technology, more money for hardware and software will be required. But throughout higher education institutions, increased funding will be needed for software design, training, maintenance costs, and technical support to the users – both faculty and students. This broader application, in turn, may lead to higher tuition fees.

Whether the financing comes from public funds, foundations, industry, or tuition and fees, the internal budgeting for technology will require close examination. Enrollment levels will have less influence on determining budget allocations than they do now. Technology's financial requirements will be built into the budget of every department as its use becomes more extensive in all disciplines.

An important factor in the financing of technology is what might be called "trade-off planning." With expanded

productivity as a major objective, the additional dollars allocated to bring technology to education should be partly offset with reduction in costs or more productive efforts. New dollars displace dollars expended in old ways. For example, the money spent on automating attendance records and tracking student progress might be offset by not having to hire additional personnel as the numbers of students increase. Or it might result in making it possible for professors to spend less time on housekeeping chores and more time on providing quality instruction.

This "trade-off planning" or displacement of costs can best be achieved by those institutions that coordinate their technology planning. In many institutions, each unit plans its own approach to the application of technologies, and often this results in mismatches of hardware and software as well as in duplication and inordinately expensive programs. Centralized coordination, with input from the various divisions and departments, will reduce the overall costs of technology applications and will guarantee consistency and compatibility.

On the other hand, "trade-off planning" is not a panacea and will result in significant savings only in very specific instances. Even in those cases, such as when faculty are relieved from certain chores for a more cost-effective use of their time, the major result is improved quality of instruction, not necessarily extensive savings. Initial outlays are significant, but the result can indeed be increased efficiency and economy with avoidance of waste. Real acceptance will come only with the understanding that in addition to certain economies and efficiencies, the critical impact of technology will be to improve quality and increase productivity.

Much of the discussion summarized above applies to colleges and universities wanting to enhance their own efforts in using technology. But two ideas transcended the boundaries of single institutions and called for immediate collaboration and action. First, a number of institutions should form consortia to engage in applied research on the uses of technology, especially for improving workplace competencies. And second, telecommunications consortia should cooperate in developing programs for underserved and unserved audiences in both urban and rural areas.

It was clear throughout the conference that we have a long way yet to go to overcome the obstacles to the intelligent use of technologies as laid out in the Lewis-Wall paper. But it was also clear that with the proper leadership within higher education institutions, we could bring the benefits of technology to millions of people throughout the nation and the world.

PART II

Discussion Paper:

EXPLORING OBSTACLES TO USES OF TECHNOLOGY IN HIGHER EDUCATION

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Colleges and universities today are faced with the challenge of keeping pace with a technological revolution of mammoth proportions. Increasingly, the young people who enter higher education as undergraduates come from homes and schools where technologies of various kinds constitute a dominating force. At the same time, colleges and universities are sending recent graduates into a world of work – from the office to the plant to the laboratory – that is becoming technology-intensive at an even greater speed.

The quick pace of technological intervention is found also in the administrative and service departments of higher education, where computing for accounting, purchasing, record keeping, and research is an everyday practice.

On the instructional side, the pace of introduction of various technologies has moved considerably more slowly, despite an increasing proliferation in the market place of computing, audio, video, and new interactive technologies, such as videodisc and two-way audio-video systems.

Although college and university instructors have experimented with information technologies for decades, the typical college professor still teaches in the manner of academicians dating back hundreds of years. Those instructors who venture into technology have often been dissatisfied with their experiences. There remains widespread skepticism on campuses stemming from the historical failure of technological interventions such as closed circuit television.

More recently, the relative lack of high-quality instructional software for computers has reenforced this skeptical view. The promise of videodisc and other interactive technologies to revolutionize teaching and learning (a promise as yet unfulfilled) creates an atmosphere of non-performance that provides yet another opportunity for faculty and critics to make excuses for the relative absence of technologies in America's college classrooms.

This paper constitutes a starting point for discussion about the role of technology in teaching and learning in higher education and focuses specifically on obstacles to the successful infusion of information technologies into the classroom. It is written at a time when colleges and universities seem poised for a giant leap forward into a variety of new technologies, a situation brought on by increasing societal pressure and the continued advances in technology.

Nevertheless, some institutions where historical resistance to technology has prevailed have avoided costly mistakes made by the more technology-enthusiastic schools now saddled with outmoded or underutilized technologies. The reverse side of that coin shows that no institution can afford to do *nothing*. The technologies will continue to evolve; there is no point in time where an institution can become involved in technology with any assurance that over time its acquisitions, too, will *not* become outmoded. For reluctant institutions, the answer may be a simple matter of careful planning and starting small – a pilot project here and there to test the waters and gain experience.

Historical Perspectives

Fully integrating information technologies into higher education is a very difficult challenge (some educators would describe it as nearly impossible). Technology advocates and skeptics alike can point to almost forty years of obvious discrepancies between promises and practices. The pace of

technological activity in the last decade on college campuses has increased, and the promises remain very much alive. Still, the anticipated match between technology and learning remains highly elusive.

Perhaps those who are impatient with the pace of change in higher education need to remind themselves that it took educators hundreds of years to learn how to make effective use of the printed word, and some maintain that improvement is still needed in the use of ink and paper, even though the textbook by now can be considered a *mature technology*. However, the demands on education today suggest that it will not have the luxury of additional hundreds of years to learn how to integrate computer, video, and audio technologies into academic instruction. Nevertheless, the challenges remain complex and the roadblocks significant. In the world of technological innovation, education has a long way to go.

Reasons for Using Technology

An examination of obstacles to the use of technology in academic instruction should start with a consideration of the reasons for turning to information technologies in the first place. When college faculty members are asked what role information technologies should play in instruction, there is nearly universal agreement that these innovations should be seen as *supplements* to traditional instruction, not replacements or duplicates of what the teacher in the classroom can do.

Faculty members often cite one or more of the following reasons for using technologies in their teaching:

- To accomplish tasks that they cannot do by themselves, such as helping students experience times, places, people, and events that cannot be otherwise incorporated into the class.
- To accomplish tasks better than they can by themselves, such as helping students visualize phenomena that are too small or too dynamic to convey effectively with print or static models.
- To perform routine teaching tasks which instructors can do but prefer not to, such as helping students overcome individual learning differences through drill and practice.
- To prepare students for the world of work, such as helping students use and apply spreadsheet, word processing, or computer-aided design technologies.
- To enhance faculty and/or student productivity, reducing time required for routine record keeping or communication, such as writing or revising or specific teaching or learning styles.
- To reach, via distance learning, those students who choose not to or are unable to attend classes on campus in the conventional manner.

Reasons for Not Using Technology

Technology is, of course, not always the solution. In fact, if used inappropriately it may become a roadblock to effective learning. Listed below are some of the reasons often cited for not using information technologies for instruction:

- When the technology is inappropriate to the educational task, such as the use of

low-production value, pre-recorded video to convey basic course content to under-motivated students.

- When the technology cannot be effectively employed, such as when a classroom has not been adequately wired for audio or video transmission.

- When the technology cannot be afforded, such as insufficient access to computers to justify making major class assignments involving computer applications to all students.

- When a combination of faculty skills and existing print materials are able to convey course content effectively to all students in a specific course.

Because of the widely different needs of time- and place-dependent learning and learning where time and place are variable, the discussion of obstacles has been divided into two sections: *On-Campus Learning* and *Distance Learning*. Within each section, obstacles are examined according to three categories: *technical, structural*, and *attitudinal*. In many ways, these obstacles overlap; to an increasing extent, the difficulties faced in on-campus and distance-learning situations are becoming similar. At the same time, the students served through each delivery means are becoming similar, as the many on-campus students also enroll in distance-taught courses and vice versa.

On-Campus Learning

Technical Obstacles

One of the most formidable challenges to the integration of information technologies into higher education is the rapid pace of technological change and, increasingly, the complexity associated with combining technologies. If money were no object, it would still be difficult to make intelligent decisions about the acquisition and use of computers and telecommunications technologies. When budgets are tight, as is the case at most colleges and universities, costly mistakes can be disastrous, with effects felt for years into the future.

With this constraint in mind, here are the major technical obstacles facing colleges in on-campus use of information technologies:

Lack of Industry-wide Standards. Incompatibility constitutes perhaps the greatest technical obstacle, as colleges and universities struggle to interpret a wide variety of hardware and software designs. This problem is exacerbated by the multitude of potential administrative, research, and instructional applications possible on a single campus or within a multi-campus system. It is further complicated by the proliferation of different types of technology, such as the wide variety of personal computers, found on campuses where purchasing decisions are decentralized and campus standards for support services have yet to be set.

Hardware and Software Complexity. The complex and unfriendly nature of both hardware and software has also been a major hindrance to instructional uses. This situation now appears to be improving, but narrow interpretations, vendor self-interest, and

the pace of technological change are working against early resolution of these barriers.

Lack of Instructional Software. The paucity of high-quality software and instructional materials remains a serious deterrent to adoption of technological innovations despite the rapidly increasing proliferation of materials on the market. Unfortunately, much of the current material still suffers from poor instructional design and/or weak content.

Instructional Requirements. Difficulty in adapting to specific teaching requirements is another roadblock to faculty adoption of technology. Issues of format, copyright, accessibility, and price loom large in the faculty assessment of what constitutes acceptable academic software.

Structural Obstacles

The policies and procedures of colleges and universities themselves are often major obstacles to instructional uses of technologies. Some are guilty of sins of both omission and commission.

Budgeting Policies. Institutional budgeting policies and practices often frustrate efforts to make the substantial up-front investments required to buy or lease expensive hardware. Departmental budgets are often inadequate to support acquisition and upkeep of computers needed for instructional purposes.

More fundamental questions, however, face those who control the budget. Are the traditional budgeting policies based on enrollment levels adequate if technology pervades all parts of the institution? How should the technology resources be managed, and what kind of support system for the uses of technology will be required and administered?

Lack of Incentives. Lack of faculty incentives and rewards for improvement in teaching is a pervasive obstacle to technology use. The tasks of learning to use computer, video, or audio technologies require considerable time. Without such incentives as released time, scheduling adjustments, or mini-grants, most faculty members find it more rewarding to focus their attention on research and writing in the traditional sense.

Lack of Training or Technical Support. By far the greatest problem facing institutions desiring widespread use of technology is training people at various levels to be able to use the technological resources. Instructors, administrators, staff, and students need to be trained to use the systems and equipment. In addition, adequate technical support and service systems for equipment maintenance and repair need to be provided.

Poor Support Services. Without adequate support services and meaningful training programs, even a highly motivated faculty member finds using technology a frustrating experience. Critical support services fall into the following categories:

- Information about hardware and software
- Evaluation of hardware and software
- Demonstrations of hardware and software
- Training and technical assistance for faculty and student users
- Maintenance and repair of equipment
- Communication with current and potential vendors
- Acquisition and cataloging of software and programming materials

- Establishment and documentation of institutional standards and procedures for software and hardware use

- Distribution of equipment and supplies (initially and on a continuing basis)

The experiences of more technology-intensive institutions indicate that variations of all these support services are needed to integrate technology into instruction effectively. The failure to provide academic users with these services, even on a modest scale, can undermine an institution's efforts to encourage greater use of technology.

Software Development. An even higher level of support is needed on those campuses where faculty members are expected to develop as well as to use technologies. The challenge of adapting or developing software is considerable, and faculty members need the help of skilled programmers and instructional designers to play this role successfully. Without such assistance, only a small minority of motivated and technically skilled teachers will produce useful instructional resources.

Financial Resources. Many colleges and universities lack the financial resources necessary to provide adequate hardware, software, or support services. Smaller and less affluent colleges and universities have a difficult time competing with larger, wealthier, and more prestigious institutions. In addition, vendor generosity often rewards the latter group disproportionately.

Access. It is difficult to have much impact on the teaching and learning process if a college cannot provide its students and faculty members with convenient access to the technology. For example, until there are sufficient numbers of computers available, faculty members will be reluctant to make class assignments that require access to computers. Colleges that are unable to provide a sufficiently computer-intensive environment may find themselves relegated to a second-class status compared to wealthier institutions. The consequences of such inequities may have a negative effect on recruitment of faculty members and students in turn.

Logistical Annoyances. Some of the obstacles can be traced to what appear to be relatively minor annoyances which, left unresolved, can build into major barriers. Among them are logistics, turf battles and even security systems.

Most college teachers have at least one war story to relate about pushing an audiovisual cart between buildings during a snowstorm or about arranging for a video or computer demonstration that fails to work properly. A faculty member who discovers that the wrong equipment has been delivered or who cannot make the software work is not likely to forget the embarrassment or the awkwardness of the situation for some time.

A student or teacher may find a computer lab inaccessible or unavailable due to security practices that close campus buildings at certain times of the day or week, or that limit access to users with certain prescribed clearances. The rationale for the security measure may be understandable, the purposes laudable, but the result may be increased frustration for students and faculty members who are locked out.

Disproportionate Access. Disagreement over who controls placement of hardware, scheduling of facilities, or selection of software may also lead to problems that students and faculty members find they can do little to resolve. When a computer lab

belonging to the math department sits underutilized while English or economics students cool their heels in long lines, struggles over who has what authority are a near certainty. Moreover, much of what is written about computers (including the manuals) can more easily be read by scientists and engineers. As the social scientists and humanists expand their uses of the technologies, the disproportionate access issue will grow.

Extra Time Required. Most faculty members report that using technology generally takes more of their time than teaching by conventional methods. This is particularly true for instructors who develop their own software or programming materials. Faculty members who are developing software almost universally report that they are devoting substantial blocks of time for which they receive no additional compensation.

Underutilization. Many campuses have installed networks of varying kinds including voice, video, and data interconnection. Often their uses are restricted to small divisions of the institution. Sometimes, too, ignorance of the existence of the technology resources on campus inhibits more widespread development and usage.

Attitudinal Obstacles

The attitudes that hinder technology use should be familiar because most people share them to some degree. Apprehension about change, fear of technically complex devices, concerns about job security, resistance to being in the learning mode, worry that students are too uncomfortable with new devices, skepticism about claims made in the name of technology, and previous negative experiences are among the many attitudes that slow the pace of technological advancement in academia.

Fortunately, even academicians change their views over time. No less fortunately, some aspects of the technology also become friendlier over time, as users become more familiar with them and as hardware and software designers make new advances to create user-friendly machines and programs.

Mechanistic Focus. In any organization faced with decisions about the introduction of new technology, it is easy to focus almost exclusively on the hardware components. While the hardware may be expensive and even flashy, the users ultimately determine how effectively the equipment is used.

An institutional bias toward mechanistic innovation, without a companion commitment to teach users how to use the equipment and to supply related support services, is an attitude that can create roadblocks to effective use of the investment made in equipment, machinery, and space. Further, a lack of any organized, systematic, and integrated approach can turn over decision making to people who do not enjoy a comprehensive, organizational perspective.

Faculty Resistance. How campus administrators spend technology budgets is not the only attitudinal impediment to effective adaptation to information technologies. Faculty members themselves are often the creators of significant obstacles through their own intransigence, ignorance, or bias related to technology and its uses. In addition, many faculty members have had quite real, highly frustrating experiences that enable them to point to past disappointments as good reasons for current resistance.

There are many reasons why faculty members resist such changes. Specifically, using technology for instructional

purposes has the following effects:

- Interferes with student-faculty communications by getting in the way and taking up too much class time
- Requires too much prior planning
- Involves working in collaboration with technicians and instructional designers rather than working alone
- Requires too much time to learn to be proficient
- Disrupts the traditional faculty authority role by forcing faculty to deal with matters outside their particular expertise
- Removes from faculty members their control of their intellectual property as their courses are transferred to video or some other technology
- Threatens faculty jobs as administrators try to substitute technology for conventional teaching modes

Distance Learning

The concept of learning that occurs between instructors and students separated by distance is probably as old as the practice of letter writing. Correspondence instruction is a more formalized version of this learning process. As new technologies have emerged, radio, phonograph records, television, video and audiotapes, computers, and other developing technologies have been integrated with print materials to facilitate teaching and learning across distances.

Historically, distance learning has been at the periphery of American education. In recent decades, it has been gradually winning acceptance as a tool for filling in the gaps in our otherwise comprehensive educational system. The proliferation of information technologies has made it easier to use distance learning techniques to meet the needs of time- and place-bound adults, as well as youth in smaller and rural high schools that lack sufficient capacity or training.

As information technologies make time and place less relevant variables in the educational process, the lines between traditional campus-based learning and distance learning are likely to blur. As more local, state, and national governments strive to meet their dual commitments to access and to quality, they are likely to take a growing interest in encouraging distance learning. Overcoming obstacles to distance learning will be an important part of this movement.

Technical Obstacles

Distance learning has two inherent problems: *providing the student with sufficient educational resources and providing timely feedback from the teacher to the student*. Information technologies can help overcome both of these problems. Unfortunately, there are some factors that hinder effective use of these technologies for this purpose.

Pace of Change. The rapid pace of technological change acts as a double-edged sword for those organizations and institutions that want to implement distance learning systems. It is difficult to design a local, regional, statewide, or multi-state delivery system that takes advantage of current technological capabilities and yet is not in danger of becoming obsolete in the near future. Knowing that this problem "goes with the territory" does not end the frustration.

Inequitable Access to Telephone Service. Although satellite-delivered video and audio lessons, computer mail, and conventional postal services can be used to reach virtually anyone in the United States, rural learners may not have equitable access. Why? Because the capacity of the new technologies to help solve the problems of isolated learners is hindered by inadequate and often prohibitively expensive telephone service or satellite downlinks.

At the same time that urban areas enjoy unprecedented telecommunications options, some rural communities simply cannot dependably use electronic mail or computer conferencing because they are on party lines or have low-quality telephone services. Even when service is adequate, electronic access to libraries and data bases and calls between students and teachers in rural areas may be impractical due to the high cost. Furthermore, the distribution pattern of the new technologies is generally market driven, which means large urban populations receive priority over more sparsely populated rural areas.

Access to Computing. Lack of access to computers can be a more serious obstacle in distance education than on campus unless the student can handily use equipment at a local school, library, or workplace, or has computer equipment at home. Lack of quality software affects distance education, as well as on-campus programs. Away from the campus, it is more difficult for the student to get help in learning how to use software or in figuring out the bugs in hardware configurations. Like their colleagues on campuses, off-campus students may have difficulty with incompatibility of systems or lack of standards for data transmission and electronic communications.

Inadequate Software Design. Many technology-based programs were designed with the on-campus student in mind, so they may contain only partial lessons or lesson elements designed to be supplemented in the classroom or laboratory. Further, simulated laboratory programs are scarce, making the distance learner's inability to get to a laboratory a definite handicap in learning in those courses that assume that a laboratory experience will be available.

Support Service Complications. Students at a distance need most of the support services of on-campus students and then some. The fact that they are distant from the campus center makes providing these services even more difficult, further complicating the many handicaps that off-campus students often face.

Basic training programs delivered by telephone and mail to get distance learning students started can ultimately result in additional training by electronic mail or computer conferencing.

Structural Obstacles

A number of the structural obstacles encountered by distance educators stem from the fact that their activities and programs often challenge rules and regulations devised for campus-based instruction. State funding policies that are based on hours of face-to-face contact are an obvious example.

Need for Collaboration. Because technology does not respect the traditional boundaries of schools, colleges, states, or regions, distance learning often involves collaboration among many organizations. For example, establishing a statewide distance learning network may entail collaboration among educators from different institutions and sectors, as well as representatives from business, government, and the communications industry.

For many in the education community, moving beyond traditional turf to

address regional or statewide needs of distance learners can be difficult. Failure to adjust to these new circumstance can hinder effectiveness, rendering relatively worthless the technological advances that make modern-day distance learning possible. At the state level, there is an absence of integrated approaches to telecommunications and computing within state governments, making it difficult to put together collaborative systems that can stretch tight budgets and envelop higher education in a comprehensive statewide service.

Transmission Across State Boundaries. Lack of policies dealing with sharing of programming across state boundaries may hinder the delivery of effective services to students or may cause complications in out-of-state tuition and similar practices which are often the subject of protracted negotiations where they apply to on-campus programs.

Access to Libraries. Off-campus students typically do not have equitable access to library systems, even though libraries increasingly offer totally automated services to students on site.

Lack of Accessing Skills. Many off-campus students can access an increasing variety of commercial data bases, but they often lack the skills necessary to use them effectively. Further, no support or training is available to help these students learn how to use such systems.

Attitudinal Obstacles

For most distance learning situations, the same attitudinal barriers exist that are found on campus. These additional hurdles are also relevant.

Faculty Resistance to Public Exposure. To the extent that a faculty member's lecture suddenly becomes public, such as through TV broadcast, faculty members may resist the notion that they are suddenly being watched by non-students and casual viewers.

Faculty Resistance to Off-Campus Learning. Some instructors are simply resistant to dealing with the student who cannot get to the campus and have little or no sympathy for the student whose life situation does not permit attending college in the traditional manner. Among these are teachers who believe they cannot teach if they "cannot see the students' faces," or who are reluctant to try interactive transmission systems that enable instructors to see students in classrooms located a distance from the campus. Some believe that "you can't teach this way," no matter what.

Poor Marketing Orientation. Some educational institutions view technology as a vehicle to enhance marketing capability, principally to concentrated markets of professionals, even though the same or similar technology also could be used to reach target markets excluded from higher education for financial or geographical reasons. It is also ironic that some colleges and universities have found technology a useful vehicle to reach urban-centered professionals but not more isolated rural populations whose access to the campus is considerably more than a scheduling problem.

In spite of these and other obstacles to technology use, there are signs of genuine progress in the development of varying uses of technology in colleges and universities. A number of professors are exploring the use of a variety of technologies, and some faculty members are developing their own software. Academic support staff are rendering invaluable service to both faculty and students. Some institutions are planning and implementing programs utilizing technologies that are institution wide.

Yet despite these advances, the obstacles noted here continue to inhibit the broad use of technologies in colleges and universities. The obstacles are complex and interrelated. It is time to move from bewailing the obstacles to planning new practices, policies, and strategies that will encourage pilot developments, expand existing usages, and cooperate with the private sector, a partnership that should embrace not only the profit motive but also the goals of education. The strategies to overcome these obstacles warrant our serious attention.

PART III

Case Study:
MARICOPA COUNTY COMMUNITY COLLEGE DISTRICT

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The Maricopa County Community College District in Arizona is composed of seven colleges and two educational centers, enrolling 120,000 students per semester (90,000 for credit and 30,000 for non-credit). This case study demonstrates how an institution committed to the use of technology has addressed the five major themes of the Round Table on Technology in Higher Education: access, quality teaching and learning environments, training and support systems, collaboration, and finance.

The Maricopa County Community College District was not always as oriented to the use of technology as it is now. In less than a decade, the District had moved from 150 terminals and personal computers to 7,000. The District has used technology as a metaphor for change, and faculty and staff have responded to the implications of technological changes in all aspects of the academic endeavor. A series of formal and informal planning meetings resulted in specific plans and budgets, and the District developed a successful $150 million capital development plan, with $31 million allocated for technology.

The entire academic community, faculty and staff, has come together to plan new projects and to modify old ones. In this process, the by-products of using technology – improved communications, a sense of sharing, and visions of a different future – have become as important as the programs themselves.

Access and Equity

The District's concern for access and equity was summarized by faculty member, David Dalby:

> *Providing access means removing any obstacles that impede or prevent the successful attainment of goals by students or faculty. It means identifying, recruiting, and serving new types of student populations; improving the kind, degree, and effectiveness of the delivery of education programs. It can involve technology, procedures, social issues, legal statutes, economic factors, instruction, administrative processes, structural facilities, or equipment.*

To provide equal access to all citizens, the District has undertaken a variety of initiatives.

Maricopa County Coalition for Literacy

There are 400,000 illiterate adults in the state of Arizona, and only about seven percent can be served with existing resources. Included in the definition of literacy is computer literacy, because society increasingly demands more than basic reading and writing skills. The Coalition, which includes academic institutions, government agencies, community-based organizations, and private employers, is designed to help develop networks and secure funding for literacy efforts. For example, programs such as the PALS (Principles of Alphabetic Learning) labs use computer-assisted instruction and videodisc technology to supplement one-on-one tutoring, thereby allowing more intense and flexible instruction and making services available to more users.

Distance Education

In 1978, Rio Salado Community College was established as a non-campus college within the Maricopa County Community College District, charged with managing alternative delivery systems for distance education. This college-without-walls uses a variety of delivery systems to serve 1,600 students each semester: broadcast and cable television, audio and video cassettes, audio and computer conferencing, and slow-scan video, as well as traditional correspondence study.

Rio Salado's newest delivery system is computer conferencing. Students can access instruction, submit assignments, and communicate with faculty and fellow students entirely through computer conferencing. Students and faculty may access the system through dial-up modems, using personal computers in their homes or offices, or through microcomputers or terminals located anywhere in the District if connected to the district-wide data communications network.

SunDial Network

The SunDial Network, Rio Salado Community College's audio teleconferencing system, enables students at remote sites as well as homebound students to take courses. The Network is also used extensively for administrative and instructional meetings by faculty and staff throughout the District as well as by other educational and non-profit groups throughout the state.

Sun Sounds

Sun Sounds is a free, statewide radio reading service for the blind and the physically handicapped. Transmitting from Phoenix and Tucson over closed broadcast signals, the service operates 24 hours a day, seven days a week. News from major newspapers, advertisements, stories, travel information, and radio theater are provided to 11,000 persons by 385 volunteers. Sun Sounds is part of a national radio reading service, and Maricopa produces about 20 programs weekly which are distributed nationwide.

KJZZ-FM Radio

KJZZ-FM operates 24 hours a day, seven days a week. Its signal extends to major population areas throughout the state. Affiliated with both National Public Radio and American Public Radio, KJZZ-FM originates a substantial portion of its programming aimed at the 25-49 age group, the largest age group using the facilities of the Maricopa Community Colleges.

Quality Teaching and Learning Environments

The use of the computer in helping create a favorable teaching and learning environment at the Maricopa County Community Colleges has rested primarily on a strategy of decentralization. More than 7,000 terminals and computers are available to support students, faculty, and staff. Most faculty have work stations in their offices. Departmental and large-scale open laboratories are also available for students to use during both day and evening.

A second strategy involves computer networking to enhance compatibility, increase efficiency, and improve computer support. Through networking, messages are easily transmitted among students, faculty, and staff. The proliferation of computers and their widespread use has helped raise the computer literacy skills of all students and faculty. In addition, the Colleges are connected through a wide area digital microwave network with 3,000 active ports for data transmission. This network also supports an inter-college voice communications system.

Student Tracking Systems

A computer software system for student tracking, MAPS (Monitoring Academic Progress Systems), is of great assistance to students in the advisory process. MAPS shows students what courses they need to complete their programs, provides curriculum

management information, and handles the degree audit. The software is available at all the Colleges in the District, so that a student's transcript can be electronically retrieved and reviewed at any campus. In addition, programs at nearby Arizona State University are on the MAPS system, thereby allowing students to see how their courses fit within the university's requirements.

Faculty Computer Literacy Project

The key to computerized instruction has been the involvement of the faculty, and by now 80 percent of the full-time faculty are computer literate. The essential element in the training of faculty was permitting them to take computers home for three months. While they experimented with the computers during that time, faculty members were required to attend one afternoon workshop each week. A new group of faculty was cycled through this program every three months, and everyone who wanted to participate was accommodated. Now many faculty members develop their own courseware and do their own programming.

One substantial change has been the faculty's attitude toward pre-packaged software. Originally suspicious because of the "not-invented-here" syndrome, faculty now worry more about the functionality of the package and are more willing to accept software from the outside.

Library Automation

The Maricopa Community Colleges now have automated systems for circulation, acquisitions, and cataloging; all materials in the districtwide library collection are barcoded. The automated library system is also fully integrated with the instructional and administrative software systems. Information access has become the watchword for all students, faculty, and staff, as well as citizens living within Maricopa County.

The library automation system provides faculty and students with on-line public access to holdings at all libraries within the District. Students and faculty are also linked by computer to nearby Arizona State University's library system. The year before automation, inter-library loans totalled 1,100. Now, with automation, a book can be delivered the next day from anywhere in the system. Inter-library loans on a busy *day* almost reach the total number of loans for a *year* prior to automation.

Writer's Network

Improving the quality of student writing has been a major objective of the Colleges and has resulted in the Writer's Network, which is used to grade the essays of students in English composition courses. Students prepare their essays in electronic form, either from their homes on personal computers or terminals or from a computer laboratory on campus. Students may use any word processing package with any spelling or syntax checking software. The instructor, who reads the essay on line, may superimpose codes and comments that are selected from a pre-defined list the instructor has prepared. The codes and comments may contain prescriptions and references for the student to use in the future. In addition to the essay preparation and grading functions, the system also feeds the grades assigned to the essays into an electronic grade book. The graded essay is returned to the student electronically.

High Tech Center

One of the Maricopa District colleges, Glendale Community College, has created a High Tech Center. In an area

roughly two-thirds the size of a football field, the Center contains 28 Y-shaped islands with 12 work stations designed to give students access to 336 microcomputers and terminals. The design permits self-paced, open-entry and open-exit learning.

Each semester, faculty-supervised instruction in 30 different subject areas reaches 9,000 Glendale Community College students, approximately half the student body. With extended hours on weekdays and weekends, the Center serves 1,000 students daily and allows students to work on assignments whenever they want and for as long a time as they need.

Ocotillo

Its name derived from a succulent plant that has multiple stems growing from one root, Ocotillo is the District planning group responsible for examining technology as a means of maintaining quality in the teaching-learning environment.

A group of faculty and staff drawn from all nine colleges began with certain questions about technology and telecommunications:

- What is the instructional agenda for technology?
- Who is in charge of the agenda?
- To date, what are the instructional and organizational benefits of commitments to technologies?
- Are we in control of the teaching/learning process, or are we driven/limited by available technology?
- How do we plan for future developments in technology?

A number of action/research groups have been formed to address the following issues as they relate to the uses of technology: collaborating across colleges; improving access; integrating learning theory, content, and technology; designing information facilities and classrooms; tapping alternate funding sources, and providing staff development. Each action/research group is led by a faculty chairperson and supported by an administrative coordinator. These planning efforts form the foundation for strategic planning for the continued use of technology. Active participation of faculty and staff working together provides the framework for successfully assessing current uses of technology and planning for future uses.

Training and Support Systems

Training has become the hallmark of technology progress in the Maricopa Community Colleges. Board members, presidents, faculty, and staff have "gone back to school" to develop a wide range of skills. The breadth of training programs has evolved gradually. At first, consulting and systems support were provided for faculty involved in computing and data processing courses. Then came the Faculty Computer Literacy Project for all faculty along with a shift to workshops and seminars covering special computer literacy topics. A more advanced stage developed with the advent of desktop publishing, and soon training emphasized spreadsheets and data bases. Currently, training programs concentrate on teaching how to access information from various sources, including the student information systems, the library/resource systems, and external data bases.

The District adheres to two fundamental concepts in its training programs.

First, training is provided at all levels; it is as important to train clerical staff as it is to train faculty members or college presidents in the uses of technology. Second, the goal is to make all users of technology more sophisticated about technology options. This emphasis on the continuous learning process has given all employees a sense of ownership of the technology.

Dissemination of Technology Information

Technological change comes about in the District only with the involvement of all concerned members of the academic community. For change to occur, members must understand the change and how it will affect their lives, and they must be able to adopt the change within their own work environments, and adapt their activities to accommodate the new approach.

For example in the Telecommunications Improvement Project, a team of faculty and staff set out to teach faculty, staff, and administrators how telecommunications, particularly voice communications, could be used as a tool to help them on their jobs. The team conducted one-on-one and small group discussions at each College, and information was disseminated to all employees in both print and electronic formats. Audio teleconferencing sessions were held as open hearings to give anyone at any College the opportunity to contribute to the planning and design effort.

This dissemination effort was so successful that the model has been adopted for introducing any new technologies or changes within the technology areas at Maricopa. Similar activities are currently under way regarding the use of video communications for on-campus and inter-campus instruction and administrative purposes.

Center for Learning and Instruction

Comprised of two instructional designers and an instructional technologist, the Center provides consultation services regarding the use of several hardware systems. Center staff also evaluate software and assist in the design of courseware. Making frequent and regular visits to all Colleges, the staff provide the technical and design support that many faculty members want and need to use the new technologies effectively.

Support Systems for Students and Faculty

Student support services are the central focus of educational telecommunications at the non-campus Rio Salado Community College. A student handbook is developed each semester and mailed directly to every student enrolled in a course using an alternative delivery system. Discussion and review sessions are held in person or through audio teleconferencing or computer conferencing. Faculty are required to keep regular office hours each week and to communicate with students through newsletters and postcards, developed by faculty in conjunction with staff. A 24-hour student hotline is available for students who cannot reach an instructor during regular office hours. A computer-managed instructional system has been established to grade and record student examinations, to print out individualized letters to students telling them their examination scores, and to analyze test questions for future revision.

Collaboration and Cooperation

Within a nine-college system such as Maricopa, collaboration and cooperation are essential elements for success. A process approach to management that involves many

people from each of the Colleges is fundamental. Equally important are collaborative arrangements with the business and industry communities and other academic institutions throughout Arizona and across the United States.

User groups on each campus meet regularly to provide advice to management on the technology agenda, report back to the Colleges on the directions taken, and help determine priorities. Currently there are active user groups for student information systems, student tracking systems, human resource systems, accounting systems, financial aid systems, academic systems, telecommunications, library, automation, and computer operations.

The "factor of nine" complicates the management of information technologies, because each College has its own president, dean, registrar, financial aid officer, fiscal agent, etc. Consequently the District has taken several steps to unify operations.

Information Technologies Executive Council

The Information Technologies Executive Council (ITEC) manages the information technology function for the entire District. Composed of four vice-chancellors, one college president, one faculty member, one member of the District Governing Board, and a vice-president from Arizona State University, ITEC approves all hardware and software purchases, sets priorities, communicates policies, and determines new initiatives.

The Council meets monthly as a board with a formal agenda, and official voting records are kept. The Council reports directly to the Chancellor of the District. ITEC provides a vehicle for balancing college and district office interests with academic and administrative interests. It requires planning input from the seven colleges and two centers, as well as from its own staff. ITEC provides a broad base of support and wields substantial political clout on behalf of the information technology agenda.

Think Tank

The recently formed Think Tank is comprised of representatives from the Maricopa Community Colleges, the Phoenix Union High School District, and eight elementary school districts that feed into the high school district. It provides a forum for discussion of issues and a means of implementing joint projects without regard to territoriality or previous practices. Its main concern is the "at-risk" student. Although solutions are ultimately grounded in effective teaching, an improved curriculum, and attention to the social and economic circumstances that affect a student's ability to learn, technology can help institutions share programs and monitor student progress.

Designed to develop and implement pilot projects, modify structures, remove obstacles, and suggest innovative solutions to problems, the Think Tank is conducting a number of projects involving the use of technology: an electronic mail link between Maricopa and the Phoenix High School District, library access and on-line college registration for high school students, and a student monitoring and assessment system.

Arizona Educational Telecommunications Cooperative

For a number of years, the Maricopa Community Colleges have worked together with other Arizona community colleges and the three Arizona universities to share technologies and/or technology-based courses on

a cost-sharing basis. That cooperation has resulted in the creation of the Arizona Educational Telecommunications Cooperative, comprised of all of Arizona's community colleges and the three universities – the University of Arizona, Arizona State University, and Northern Arizona University. The goal of the cooperative is to establish educational initiatives that can be addressed by a statewide telecommunications network. The state legislature has been asked to fund a statewide needs assessment, which could lead to construction of a statewide network in the early 1990s.

Business/Training Partnerships

The Corporate Services Division was created at the District level to contract with private industry to provide quality training programs. The Division has major training contracts with many of the leading industries in the Phoenix area. The Colleges train more than 5,000 Motorola employees, and General Motors supports a training institute for several western states at one of the Maricopa Colleges. Technology also supports sophisticated training programs for Honeywell, McDonald-Douglas, B.F. Goodrich, and other major businesses in the state and nation.

Partnerships with Technology Providers

A three-way partnership of Digital Equipment Corporation (DEC), Information Associates (IA), and the District has brought millions of dollars in savings for hardware procurement and resources for developing new software packages. A team of programmers from Information Associates is housed at Maricopa full-time, and DEC and IA provide corporate assistance for software developments used in projects described above.

Another partnership with NEC America, Inc. and NEC Home Electronics (USA) enables Maricopa to demonstrate digital video technology using NEC's video codecs across Maricopa's digital microwave network. Several video applications are being developed for this new technology.

Consortia and Professional Organizations

Maricopa is represented on the eleven-person executive committee of the prestigious Business-Higher Education Forum, comprised of 40 of the largest Fortune 500 companies and 40 of the largest colleges and universities. The Forum's objective is to influence Congressional and White House policy on the nation's technology and science agendas.

The Colleges long have been involved in regional and national technology-oriented groups such as the League for Innovation in the Community Colleges, the College and University Systems Exchange (CAUSE), the Instructional Computing Educational Consortium, the National University Teleconferencing Network (NUTN), the Instructional Telecommunications Consortium (ITC) of the American Association of Community and Junior Colleges (AACJC), and the Public Service Satellite Consortium (PSSC).

International Collaboration

During the spring 1989 semester, Rio Salado Community College, the non-campus college of the District, along with Austin Community College in Austin, Texas, offered a marketing course with Adelaide College of Technical and Further Education in Adelaide, Australia, using audio teleconferencing. Six international linkup sessions featured marketing experts as guest speakers.

Finance

Central to all technological developments at the Maricopa Community Colleges has been the question of how technology would be financed. The desire for new technology continues to grow, and up-front costs are high. In the early years, a policy loosely described as "under-management of the technology agenda" prevailed. That meant that technological advances would, for the most part, come out of annual budgets, and it was up to each College to decide how it would finance technology.

Glendale Community College offers an example of how this policy was successfully implemented. Faculty and administrators began discussion about the importance of the appropriate uses of technology. Debate was heated and there were great disagreements. By the time resources were reallocated to support faculty and students in the use of technology, general consensus had been achieved. Glendale confirmed one of the most important principles for introducing technology and mobilizing support: Have decisions about the technology made at the level where technology will be used.

No matter how much money is squeezed from ongoing budgets for technological advances, eventually large outlays of up-front money will be required. At Maricopa this came in the form of a $150 million capital development plan, of which $31 million over ten years was designated for acquisition of a telecommunications system, expansion of computing hardware and software, and construction of a microwave network to connect all college locations for voice, data, and video communications.

The Information Technologies Executive Council (ITEC) allocates approximately $3 million yearly: $1 million to the seven colleges and two educational centers, $1 million to support the computing network, and $1 million for special projects. College allocations are awarded on a base dollar amount plus a per student amount to each College. Careful plans and documentation must be submitted by each College.

Passed in September 1984, a $75 million bond issue marked a significant achievement in gaining public support for information technologies. The District has also dedicated a large amount of its regular budget to making technology an integral part of instruction and administration at the Colleges. Since 1984, $15 million has been spent in direct support of both academic and administrative computing, and the number of work stations has grown by 6,000. Overall, Maricopa has spent about $33 per headcount student, or $75 per full-time equivalent student, for information technologies.

PART IV

Case Study:
ROCHESTER INSTITUTE OF TECHNOLOGY

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This case study demonstrates how a four-year college has incorporated technology into almost every phase of its operations and illustrates the themes of the Round Table. The Rochester Institute of Technology (RIT) is composed of nine colleges and enrolls 13,000 students; it offers more than 200 academic programs. Of the 11,600 undergraduate students, approximately 3,000 are enrolled part-time.

In 1985 Thomas Plough, Provost and Vice-President for Academic Affairs, proposed that

> *Rochester Institute of Technology closely identify itself with those powerful technologies – even more powerful in their interactivity – which are literally transforming the way we work, think, and live, a transformation as profound as the agricultural and industrial revolutions – applied communications technologies. These changing technologies provide opportunities to employ electronic and telecommunications instructional delivery systems far more extensively and systematically than we do at present.*

The administration's advocacy has created a climate of support for information technology to grow and prosper at the institution.

Access and Equity

Each year almost 1,500 students participate in courses delivered off campus through distance learning techniques. The needs of the learner and the learning situation determine the choice of delivery method for RIT's distance education programs.

As early as 1970, RIT's College of Engineering responded to special needs by offering advanced courses via videotape at local industrial sites. Since 1980, RIT has used a mixture of technologies to bring learning to students where they live or work. The Telecourse Office initially offered two video-based courses on a suburban cable television system to 56 students; since then more than 4,500 students have enrolled in telecourses offered both on cable and broadcast television. Each year, more than 800 students are enrolled in 30 classes offered on video.

Videotapes are also available on campus, at two industry learning centers, and for use by students on their home VCRs. For example, courses in engineering technology are offered at Jamestown, New York, 120 miles from the campus; instruction makes use of RIT-produced videotapes and real-time conferencing with an interactive, PC-based telewriter and speaker phone.

Video materials are purchased from major producers and modified with RIT-produced introductions, summaries, and supplementary programs. Audiotapes, study guides, and text materials provide clear learning guidelines. Communications take place between faculty and students by telephone, mail, and optional meetings.

Currently a dozen telecourses use audioconferencing as one possible interaction technique. Occasional courses have been offered totally via audioconferencing, and experiments are under way to have entire courses taught this way. Speaker phones have been used to bring outside speakers to campus classes, and audioconferences via bridged telephone calls permit private discussions between students and faculty.

Computer conferencing enables students to create and submit homework; receive feedback rapidly; interact with instructors and other students in the class; and access software, library resources, and advisory information. Currently 20 courses are taught by

means of computer conferencing. More than 50 other courses use computer conferencing for open discussions, and several self-tests have been initiated on computer.

As the site of the National Technical Institute for the Deaf, RIT has explored extensively the use of computer-based communications systems. For example, one instructor uses captioned video materials and computer-based communications (with a speech board) to teach a course to both hearing-impaired and hearing students. Hearing-impaired faculty have used computer conferencing as the main system of course delivery for their students. A speech synthesizer is available at the computer center for student use. The library also houses a Kurzweill reader to provide access to print material for the blind and a closed caption decoder attached to a VCR for hearing-impaired viewers.

RIT has implemented touchtone telephone registration with a voice response mechanism. The student calls from a touchtone phone, and the voice response unit asks for the student's ID number, course requests, etc. Students can register, drop and add courses, and receive immediate feedback on the success of their registration request. A typical registration takes about four minutes. The system has been modified to permit the hearing-impaired to use a keyboard and screen to enter and receive information.

Quality Teaching and Learning Environments

As a comprehensive technological institution, RIT's teaching – both what is taught and how it is taught – is subject to the changing nature of technology. RIT encourages faculty to make use of technology to improve the quality of instruction.

RIT currently has 2,300 devices connected to its central computing system – about 1,900 personal computers and 400 work stations. Over 15,000 academic computer systems accounts exist. Four personal computer labs with a variety of hardware and software are available for open use seven days a week, in addition to college-dedicated labs for students in specific programs. A fiber optic cable provides the backbone for a campus-wide network, with all buildings wired for voice, video, and data communication. Plans call for the activation of computer ports in all residence halls in 1990.

Classrooms and lecture halls are equipped for telephone and computer access and cabled for closed circuit video. Overhead projectors and screens are available for use. Media equipment (including audioconferencing equipment, projection video, and computer display units) with operators are provided on request. These services extend to off-campus programs as well, which currently account for about five percent of requests.

An extensive, broadcast-quality production facility includes a television studio, which is used by communication, psychology, and business classes to record student presentations. A 20-station language laboratory supports foreign language instruction and English as a Second Language courses.

RIT's library catalog is accessible through the on-campus computer network or by modem and telephone lines for off-campus learners. RIT also has access to numerous other library systems and data bases, computer conferencing systems, and more recently computerized research programs in the form of collegial conferencing through the New York State Educational and Research Network.

The Library has recently installed a second-generation computer system and is

adding to its collection of CD-Rom materials. The Library currently has eight CD-Rom stations and is planning for the installation of a multiple-user CD-Rom network. Planning is also under way for creation of an Imaging Science Resource Center, which would utilize state-of-the-art communications technology to access imaging science information and data bases throughout the world.

The Registrar is installing an Automated Degree Audit System to match course work with degree requirements and also provide a system for academic monitoring and tracking.

Training and Support Systems

RIT's goal is to train all faculty and students in the use of technology. RIT realized that faculty and students would need more than computer *literacy*; they would need computer *competency*. Competency would have to be discipline specific, and training would have to begin with the faculty if technology were to be integrated successfully into the instructional process.

Training and support systems operate at several levels. First, professional staff from the Academic Services and Computing Division, Distance Learning Projects, and the Library offer support to the faculty. From the professor about to use the on-line catalog for the first time to the faculty member about to teach via video or computer conferencing, RIT's emphasis is on providing support to the extent that the professor is comfortable using the technology.

Instructional Media Services offers help in locating materials and purchases media at the request of faculty. Materials such as graphic screens for the telewriter and videotapes of lectures are produced to support distance learning instruction.

For faculty and staff who need more extensive help, Instructional Media Services offers six or more workshops each year to introduce new audiovisual technology such as liquid crystal display units, audioconferencing speaker phones, and desktop publishing software. A more sophisticated level of training and support comes in the form of pilot projects to assist professors in testing alternative delivery systems such as videotapes to reduce repetition of demonstrations or scripted, full-tv productions.

In 1981, RIT held its first workshop for faculty on microcomputers. For the next five years, two-week summer workshops were offered for faculty and staff. The focus and content of the workshops evolved as software and hardware developed. In recent years, the workshops have aimed at developing new classroom uses for generic software tools such as data bases, spreadsheets, and word processing.

During this same period, computer literacy courses for students were initiated, and RIT now seeks to have all students demonstrate proficiency in computer-based technology as a general tool by the end of the first year and as a professional tool by the time they graduate. Every year more than 500 workshops are offered to students, faculty, and staff. In addition, a wide variety of user guides are distributed.

Collaboration and Cooperation

One of the most significant developments in the advanced uses of

technology came with the establishment of the Division of Academic Services and Computing. Comprised of the Library, the Office of the Registrar, Instructional Media Services, Information Systems and Computing, and Distance Learning Projects, the Division is headed by an associate vice-president who reports directly to the provost and vice-president, academic affairs. The Division employs 155 staff members, of whom 87 are professional staff.

Thus, the professional staff responsible for introducing technology systems and keeping them functioning all work together to provide systems support for learning. Increasingly, their responsibilities overlap, and projects depend upon interactive dialogue which is carried on by electronic mail, telephone, and personal contact. Audio, video, and computer technologies operate from a common base, making it easier for professional staff to collaborate on any given project.

Within each unit, faculty opinion and involvement are solicited. There are a number of advisory committees such as the Institute Academic Computing Committee and the Library/Faculty Committee. Instructional Media Services and the Director of Distance Learning Projects bridge departmental and college lines by previewing, purchasing, and preparing media after determining needs for instructional delivery and support systems.

In 1985, RIT downlinked seven nationally distributed training programs through the College of Continuing Education and the following year installed a C and Ku Band receiving dish, which has enabled the institution to bring hundreds of satellite-delivered programs from around the world. Since installing the dish, RIT has received over 400 programs in a wide variety of disciplines.

For ten years RIT and Eastman Kodak have jointly sponsored a series of lectures on the graphic arts and photography; in 1988 they took the series nationwide. Collaboratively four RIT departments and two units within Kodak conducted a teleconference that went to 569 sites with an estimated audience of 15,000.

RIT has a long tradition of applied research. In the last two years, more than $10 million in equipment support has been provided by business and industry. In return, the Centers for Microelectronic and Computer Engineering, Computer-Aided Design, and Imaging Science cooperate on a regular basis with industry and business (as well as with government) to facilitate effective technology transfer between the educational and industrial sectors. RIT is currently working on plans for a Center for Integrated Manufacturing Studies. A key element in this $33 million facility will be the use of distance learning technology for the purpose of technology transfer.

Another instance of corporate collaboration was Apple Computer's support in establishing a program of instruction in writing and the graphic arts with the Colleges of Liberal Arts and Fine and Applied Arts. This led to the establishment of a Macintosh microcomputer lab, which is used by students in writing and art and design.

The KEY program took RIT into another significant area of education. Students in three rural school districts outside of Rochester take courses for credit through a mixture of delivery techniques such as the computer-based telewriter, computer and audioconferencing, and videotapes. Courses have been offered in calculus, economics, U.S. politics, and English composition and literature.

The University of Rochester and RIT have jointly created the Rochester

Consortium for Distance Education to explore technology-based delivery of instruction. Their first project -- a four-part video conference, Economics for Educators – originated from the Eastman Kodak Company's KBTV studio and satellite uplink. Driven by a new state-mandated requirement for a twelfth-grade economics course, twenty sites across New York State received the broadcasts and interacted by two-way audio. Featuring economists, curriculum specialists, and social studies teachers, the presentation included an actual economic simulation with the teachers at the downlink sites acting as students.

Finance

The Division of Academic Services and Computing has a yearly operating budget of approximately $10 million, indicating strong support for centralized technology services, even as much of the decision making is left to the faculty and staff. For example, the Instructional Media Services subsidizes up to $30 of the rental or production cost of any one media request. This allows faculty to make slides, audiotapes, or transparencies or to rent current films and video without cost to their departments.

Media is purchased at the request of faculty with few strings attached. If an expensive piece of software can be used by several departments, shared purchase is negotiated. The library often shares in the purchase of requested media, using its material funds. For services provided through the Division, charges are based on incremental costs for materials and student help; in most cases no attempt is made to recover costs for overhead or staff time for academic or instructional projects.

To encourage faculty to continue improving and enhancing instructional offerings, a fund of $100,000 a year has been set aside for projects related to productivity. Five faculty members from different disciplines administer the grant program and recommend distribution of the funds. Distance learning programs are a priority for the grants, and funded projects have included the development of computer conferencing, the use of audioconferencing, the use of the telewriter, and production of complete courses on tape for distance learners.

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